COURSE OF INSTRUCTION

. . IN THE . .

MECHANICAL ENGINEERING DEPARTMENT

. . AT THE . .

MICHIGAN STATE AGRICULTURAL COLLEGE

. . . 1893-4

AGRICULTURAL COLLEGE P. O., MICH.
RAILWAY STATION, LANSING.

ROBERT SMITH & CO., STATE PRINTERS AND BINDERS, LANSING.

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RAILWAY STATION, LANSING.

COLLEGE CALENDAR FOR 1893-4.

1893.

Monday, February 20, Spring term begins at 8 p. m., the first week continuing through Saturday.

Friday, March 31, Examinations on half-term studies.

Friday, May 12, Spring term ends at noon.

Monday, May 22, Summer term begins at 8 p. m., the first week continuing through Saturday.

Friday, June 30, Examinations on half-term studies.

Sunday, August 6, Baccalaureate sermon.

Monday and Tuesday, August 7–8, Closing examinations.

Wednesday, August 9, Commencement.

Wednesday, August 30, College year begins at 8 p. m., the first week continuing through Saturday.

Wednesday, August 30, Entrance Examinations begining at 8 a. m.

Friday, September 29, Examinations on half-term studies.

Friday, November 10, Autumn term ends.

1894.

Monday, February 19, Spring term begins at 8 p. m., the first week continuing through Saturday.

Friday, March 30, Examinations on half-term studies.

Friday, May 11, Spring term ends at noon.

Monday, May 21, Summer term begins at 8 p. m., the first week continuing through Saturday.

Friday, June 29, Examinations on half-term studies.

Friday, August 10, Summer term ends at noon for all but the graduating class.

Sunday, August 12, Baccalaureate sermon.

Tuesday, August 14, Commencement.

Monday, August 20, College year begins at 8 p. m., the first week continuing through Saturday.

Monday, August 20, Entrance Examinations begining at 8 a. m.

Friday, September 28, Examinations on half-term studies.

Friday, November 9, Autumn term ends.

1895.

Monday, February 18, Spring term begins at 8 p. m., the first week continuing through Saturday.

SCHOOL OF MECHANICAL ENGINEERING.

FACULTY.

*OSCAR CLUTE, M. S., President.

†LEWIS G. GORTON, President Elect.

HOWARD EDWARDS, M. A., LL. D.,
Professor of English Literature and Modern Languages.

LESTER P. BRECKENRIDGE, Ph. B.,
Professor of Mechanical Engineering and Director of the Mech. Dept.

HERMAN K. VEDDER, C. E.,
Professor of Mathematics and Civil Engineering.

FRANK S. KEDZIE, M. S.,
Adjunct Professor of Chemistry.

WILLIAM S. HOLDSWORTH, M. S.,
Assistant Professor of Drawing.

PHILLIP B. WOODWORTH, B. S., M. E.,
Assistant Professor of Physics.

ALVIN B. NOBLE, B. Ph.,
Assistant Professor of English Literature and Modern Languages.

FRED W. McNAIR, B. S.,
Assistant Professor of Mathematics.

WILLIAM H. VAN DERVOORT, B. S., M. E.,
Assistant Professor of Practical Mechanics.

WARREN BABCOCK, B. S.,
Instructor in Mathematics.

WILBUR O. HEDRICK, B. S.,
Instructor in English.

A. L. WESTCOTT, B. M. E.,
Instructor in Mechanical Engineering.

WALTER D. GROESBECK, B. S.,
Foreman of the Iron Shop.

ALBERT R. CURTISS,
Foreman of the Wood Shop.

PAUL THEADORE,
Foreman of the Forge Shop.

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*Resigned, to take effect August 30, 1893.
†Appointed, to take effect September 1, 1893.

FOUNDATION AND HISTORY OF THE COLLEGE.

The Michigan State Agricultural College was established by an act of the Legislature of Michigan, in 1855; and the organization of the institution given into the charge of the State Board of Education.

A farm, then in the woods, of 676 acres, lying three and one-half miles east of the city of Lansing, was purchased and buildings erected, and on the 13th day of May, 1857, the College was formally opened for the reception of students. It is thus the oldest college of its kind in the country.

In 1861 an act of reörganization created the State Board of Agriculture, and placed the College under its control. This act, with but few subsequent modifications, constitutes the present organic law of the College.

The appropriations of the Legislature of '87 have enabled the College materially to enlarge its facilities in the direction of horticultural science and art, and in the mechanic arts.

COURSES OF INSTRUCTION.

There are two courses of instruction :

I. Agricultural Course. (See large catalog.)
II. Mechanical Engineering Course.

It is the object of the course in Mechanical Engineering to give to the student a thorough training in the theoretical principles underlying the science of machines and mechanics, at the same time to enable him to become practically familiar with the numerous applications of principles which have become of such inestimable value to the human race.

REQUIREMENTS FOR ADMISSION TO THE MECHANICAL DEPARTMENT.

Candidates for admission to the Freshman class must bring testimonials of good character, and must be not less than fifteen years of age. The entrance examinations embrace the following subjects: Arithmetic,

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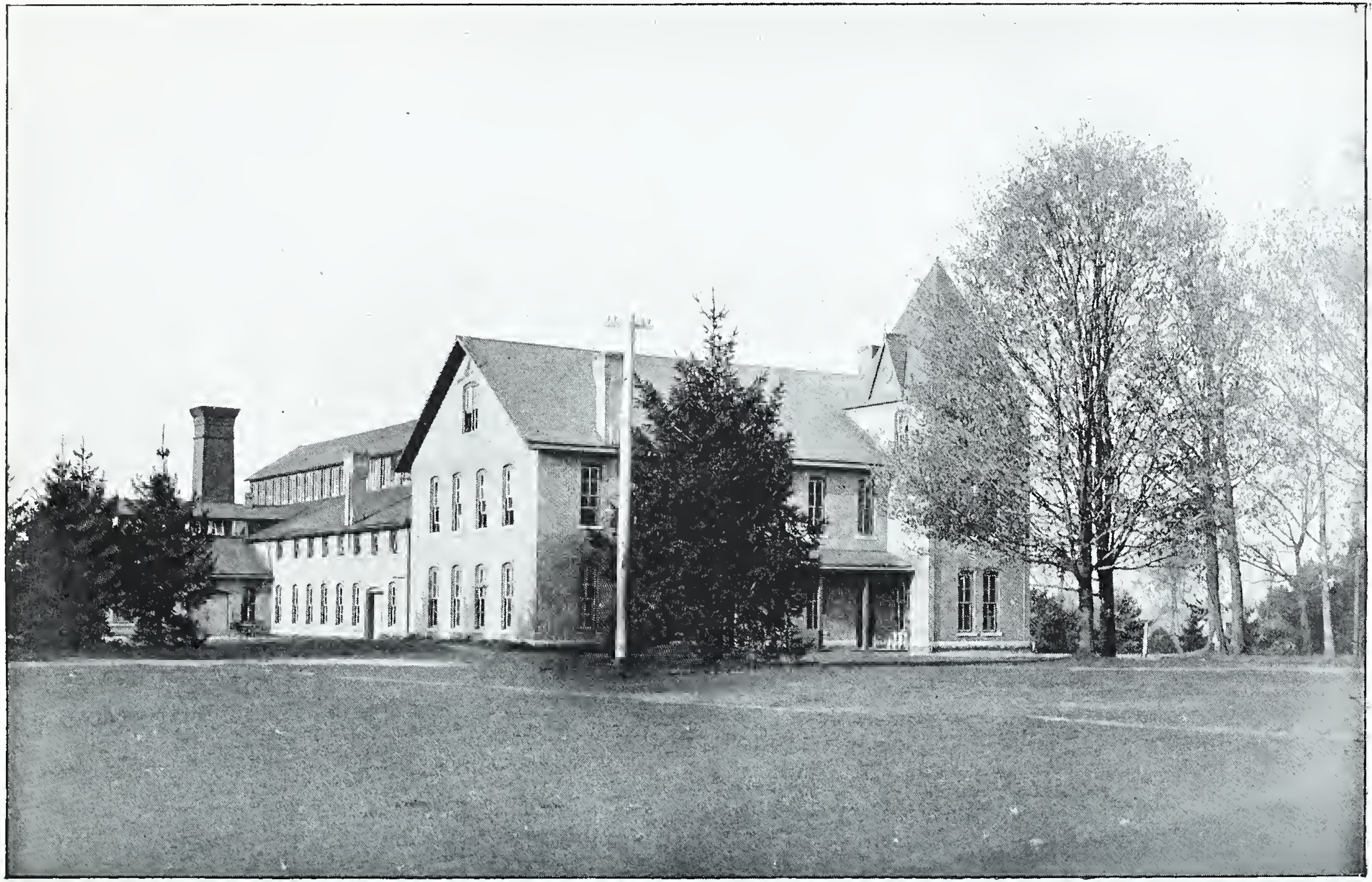


Mechanical Laboratory.

Geography, Grammar, Reading, Spelling, Penmanship, History of the United States, and Algebra as far as Quadratics.

A candidate who is over eighteen years of age may, at the beginning of the Fall term, be conditionally admitted to the Freshman class without examination.

Any person presenting a teacher's certificate is admitted without examination.

The graduates of certain graded schools are admitted on presentation of certificate of graduation.

Persons of suitable age and requirements are admitted and allowed to do special work in shop practice, Draughting, Designing, or any regular class work, provided they sustain the examination required to enter the Freshman class and have had sufficient training and preparation to pursue successfully the studies selected.

EXPENSES.

No charge is made for tuition except for residents of other states, who are charged a fee of $5.00 a term. Matriculation fee, $5.00; Graduation fee, $5.00; Room rent, $3.00 to $7.00 a term; Incidentals, $2.50 a term. Total expenses per year while at the College will range from $125.00 to $200.00. There are three terms in the year.

DEGREES.

The student in this department is granted the degree of Bachelor of Science upon the completion of the full course of four years.

Opportunities for instruction in Post-graduate studies will be offered the graduates of this College and of other similar institutions. The degree of M. E. will be conferred at the completion of this work.

MECHANICAL ENGINEERING COURSE.

(Numerals denote the number of hours per week.)

FRESHMAN YEAR.

Autumn Term.—Algebra, 5. Drawing, 8. English, 5. Rhetoricals, 2. Shop work, 10.

Spring Term.—Algebra, 5. Geometry, 5. Free Hand Drawing, 6. Elocution, 2. Physics, 4. Physical Laboratory, 2. Shop work, 8.

Summer Term.—Geometry, 5. Descriptive Geometry, 5. Rhetoric, 5. Physics, 4. Physical Laboratory, 2. Shop work, 10.

SOPHOMORE YEAR.

Autumn Term.—Trigonometry, 5. Work Shop Methods, 2. Descriptive Geometry, 6. Rhetoricals, 2. Physics, 4. Physical Laboratory, 2. Shop work, 12.

Spring Term.—Analytical Geometry, 5. Surveying, 2. Surveying (field work), 2. Drawing and Machine Design, 4. Rhetoric, 5. Shop work, 8. Tactics, 2.

Summer Term.—Calculus, 5. Elements of Machine Design, 10. Steam Engine, 3. Shop work, 10. Rhetoricals, 2.

JUNIOR YEAR.

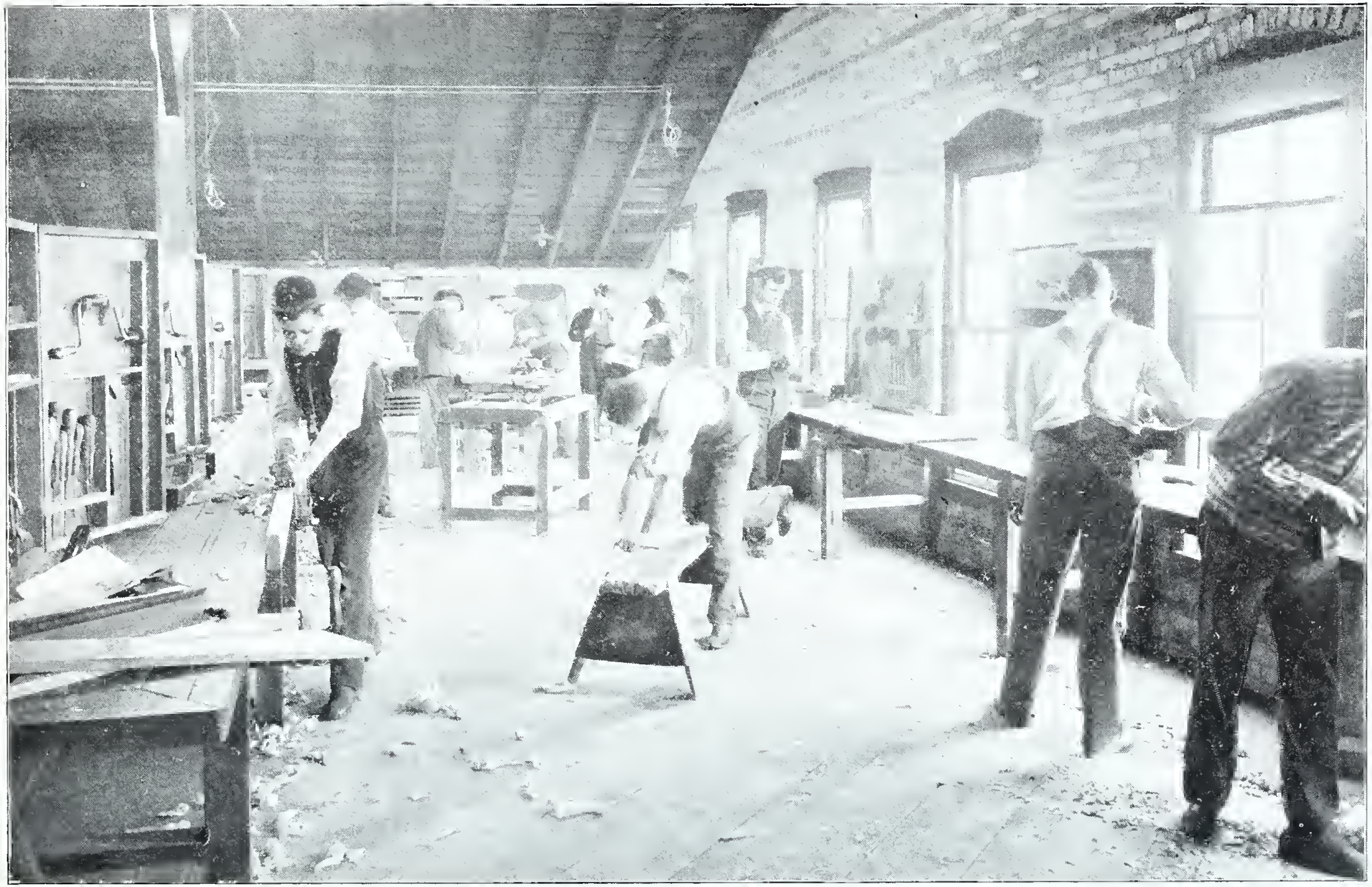
Autumn Term.—Calculus, 5. Machine Design, 6. German, 5. Chemistry, 5. Chemical Laboratory, 2. Shop work, 6. Oration.

Spring Term.—Mechanics of Engineering, 5. Steam Boilers, 1. German, 5. Chemistry, 3. Chemical Laboratory, 2. Machine Design, 6. Shop work, 8. Oration.

Summer Term.—Mechanics of Engineering, 5. Strength of Materials, 5. Testing Laboratory, 2½. German, 5. Shop work, 10.

SENIOR YEAR.

Autumn Term.—Graphical Statics, 3. Valve Gears, 2. Thermodynamics, 5. Steam Engine Design, 10. Shop work, 10. Oration.



View in One End of Wood Shop.

SPRING TERM.—Hydraulic or Electrical Engineering, 5. Kinematics, 5. Advanced Designing, 10. Steam Engineering Laboratory, 6. Electrical or Hydraulic Laboratory, 4.

SUMMER TERM.—Civil Engineering, 4. Field Work, 2. Original Design, 6. Lectures on Engineering Practice, 2. English Masterpieces, 5. Thesis work, 10. Oration.

MECHANICAL ENGINEERING COURSE IN DETAIL.

FRESHMAN YEAR.

AUTUMN TERM.—*Algebra* 5—The work of this term will include a review of factoring and indices, quadratic equations, progressions, arrangements and groups, and the binomial formula. Prof. McNair and Mr. Babcock.

English, 5—A study of the English sentence, including punctuation, supplemented by elementary lessons in Etymology. The practical ends aimed at are, the writing and speaking, and the training of the critical and analytical faculties. Prof. Noble.

Rhetoricals, 2—Exercises in expressive reading; work based on some selection from standard prose, as Irving's "Legend of Sleepy Hollow." Exercises in word study; two selected readings. Mr. Hedrick.

Mechanical Drawing, 8—Use and care of instruments. Useful geometrical constructions. Exercises in projection drawing. Designing and drawing screw-threads, conventional methods of representing screws. Designing and drawing various kinds of fastenings. Drawing from parts of machines, tools, etc. Tracing. Prof. Holdsworth.

Shop Work, 10—The work done relates to the primary operations of carpentry, such as exercises relating to the use of tools, putting tools in order, and the construction of a series of exercises, graded according to the skill of the student. The work of these is confined principally to carpenter and joiner work. Practice is given in the construction of mortise and tenon, dove-tail and other joints. Mr. Curtiss.

SPRING TERM.—*Algebra*, 5—This term's work will cover the subjects of undetermined coefficients, series, loci, Horner's method of approximation, and logarithms. Prof. McNair and Mr. Babcock.

Geometry, 5—Plane Geometry, as contained in the first five books of Byerly's Chauvenet. In this subject the effort will be not so much toward covering a given amount of ground as toward developing on the part of the student the power of independent reasoning. Prof. McNair and Mr. Babcock.

Elocution, 2—Work as in previous term, with the addition of the study of gesturing. Study of synonyms and antonyms, and common errors in the use of words. Two declamations. Mr. Hedrick.

Physics, 4. *Laboratory*, 2—Begins a year's course of popular lectures and quizzes supplemented by laboratory work. The term is given to a study of the composition and general properties of matter, force, motion, system of units, hydrostatics, specific gravity, hydrodynamics, properties of gases, atmosphere, barometer and apparatus dependent on air. Fully illustrated by lecture table experiments. Laboratory work consists of quantitative experiments. Prof. Woodworth.

Free-hand Drawing, 6—Sketching various fastenings, parts of machines, etc.; such as keys, rivets, screws, strap ends, pedestals, pillow blocks, hangers, brackets. Sketching from machines. Time sketches. Memory sketches. Isometric sketches. Prof. Holdsworth.

Shop Work, 8—During the second term the work relates to advanced joinery, turning, and cabinet making. Practice will also be given in the use of machine tools for working wood. Mr. Curtiss.

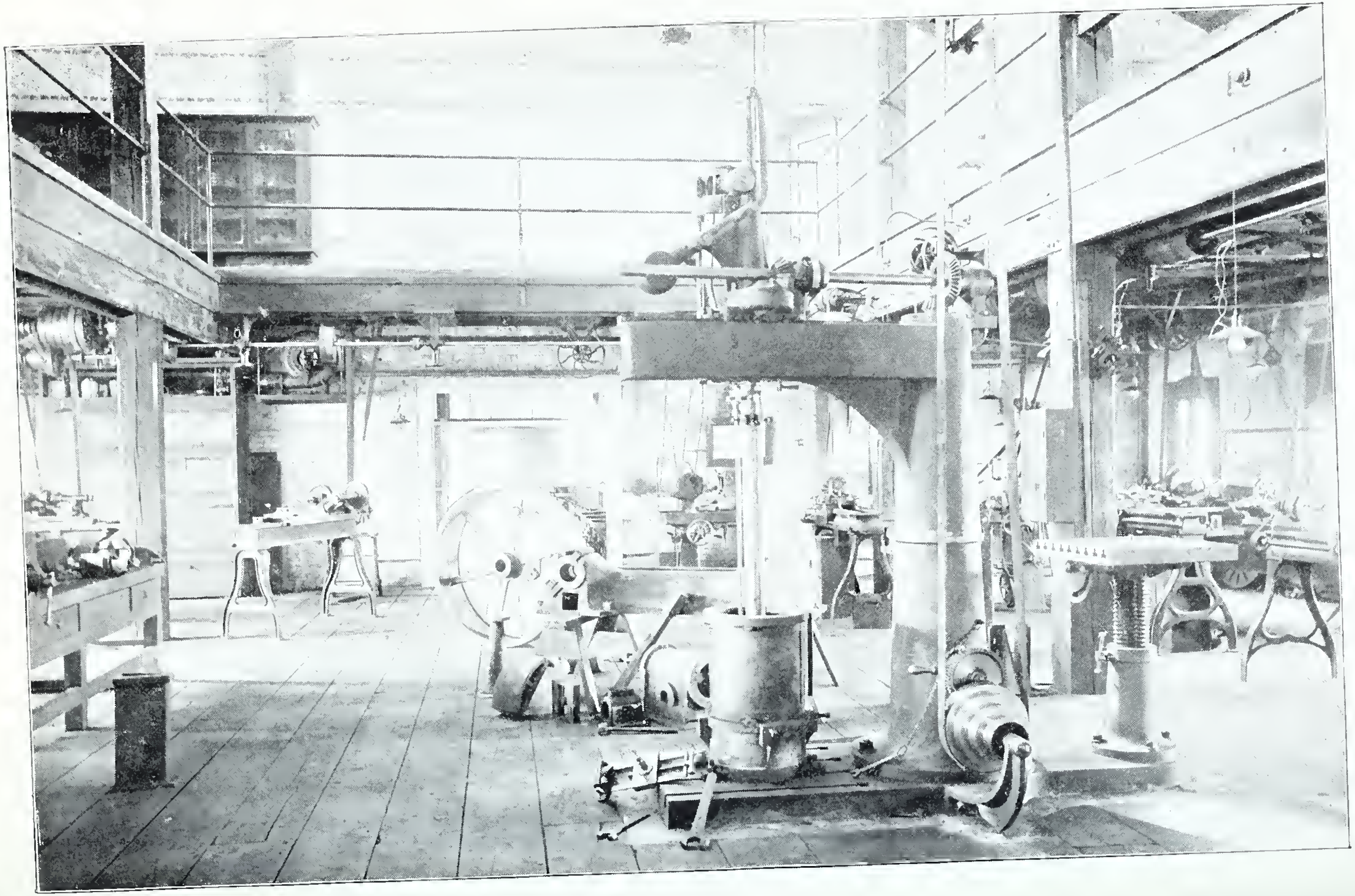
SUMMER TERM.—*Geometry*, 5—Solid (including Spherical) Geometry, with the text-book mentioned above as a guide. Prof. McNair and Mr. Babcock.

Rhetoric, 5—The term is employed in the study of style and such elementary principles of invention as are necessary for the guidance of the student in the writing of numerous exercises, principally narrative and descriptive. Prof. Noble.

Physics, 4. *Laboratory*, 2—The second term is given to the study of sound and light, lectures and quizzes. The topics in sound are its production, propagation, reflection and refraction; theory of music, analysis of sound and migratory motion. In light, the subjects are transmission, velocity, photometery, reflection, refraction, despersion, optical, instruments, sources of light and polarization. Almost all principles, and illustrated by lecture table experiments and qualitative measurements and made by students in laboratory practice. Prof. Woodworth.

Descriptive Geometry, 5—First term, consideration of descriptive geometry as applied in machine drawing. Planes of projection, nomenclature, points, lines and planes. Elementary problems, one hour daily. Prof. Holdsworth.

Shop Work, 10—During this term the time is devoted to the making of patterns and core boxes, particular attention being given to the principles of molding. So far as is consistent with good instruction, the work in the wood shop is applied to articles actually to be used. Out of the regular practice hours, students are allowed the use of a case of tools for private work. Mr. Curtiss.



View in Machine Shop.

SOPHOMORE YEAR.

AUTUMN TERM.—*Trigonometry*, 5—The course includes both Plane and Spherical Trigonometry. The ratio system is used exclusively, and considerable prominence is given to the solution of trigonometric equations. Prof. Vedder.

Rhetoricals, 2—Study of words continued, together with practice in rhetorical analysis, founded on selections from Webster or Macaulay. Extemporaneous speeches, essay and declamation. Mr. Hedrick.

Physics, 4. *Physical Laboratory*, 2—Of the last term of the year's course, the first half is given to the subject of heat, the last half to magnetism and electricity. In heat the study is of the dynamic theory, expansion, vapor tension, latent heat, hygrometry, specific heat, etc. In magnetism, the properties of magnets and the processes of magnetism. In electricity, its sources. The units of frictional machines, batteries, measurement of voltage, resistance and current. Inductive currents, magneto and dynamo. As in preceding term, the laboratory work is largely quantitative and students become familiar with apparatus and methods. Throughout the course, Ganot is used as a reference book. Prof. Woodworth.

Descriptive Geometry, 6—Second term, construction and classification of lines, generation and classification of surfaces. Problems relating to planes, tangents and surfaces. Intersection of surfaces by planes. Intersection of surfaces. Application of descriptive geometry to drawing important mechanical constructions. Prof. Holdsworth.

Work Shop Methods, 2—Consists of a course of lectures giving in detail a description of the hand and machine tools used in the shop, together with instructions as to the most approved methods of operating them. Two lectures a week, manifold copies furnished each member of the class. Prof. VanDervoort.

Shop Work, 12—The work of this term is carried on in the forge shop, where the student receives instruction in welding and forging of wrought iron and steel, tool making, tempering, etc. Mr. Theadore.

SPRING TERM.—*Analytical Geometry*, 5—Comprises an elementary treatment of the conic sections, general equations of the second degree, and an introduction to the subjects of Higher Plane Curves, and Geometry of Three Dimensions. Prof. McNair.

Surveying, 2. *Surveying, Field Work*, 2—An elementary course in compass, chain and level work, principally devoted to practice with these instruments and to the necessary calculations to reduce such work. Prof. Vedder and Mr. Babcock.

Rhetoric, 5—A study of invention, including the kinds of composition and the selection and arrangement of material. The written work of this term is principally in Exposition, Argumentation and Persuasion. Prof. Noble.

Drawing and Machine Design, 4—Tracing and blue printing—general views from given details, elements of machine design begun. Prof. Holdsworth.

Shop Work, 8—At the beginning of this term the student is brought into the machine shop where he remains during the balance of the Sophomore year, the Junior year and first term of his Senior. During this term he receives instruction in chipping, filing and elementary lathe and planer work. Prof. VanDervoort and Mr. Groesbeck.

Tactics, 2.

SUMMER TERM.—*Differential Calculus*, 5—A course given partly by lectures and partly from Taylor's Elements of the Calculus. The endeavor is to give the student a clear idea of the logic of the calculus, as well as a working knowledge of the subject. The course includes applications of differentiation to the development of functions, maxima and minima, indeterminate forms, and curve tracing. Prof. McNair.

Rhetoricals, 2—Study of oratorical masterpieces, selections from Burke, extemporaneous speeches. One oration. Mr. Hedrick.

Steam Engine, 3—A study of the details of modern steam engines and the mechanical principles involved in their construction and operation. Effect of weight and speed of reciprocating parts in modifying the pressure on crosshead, crankpin and crankshaft. Different types of valves and valve gears; also graphical representation of the motion of valves driven by eccentric, both single and double. Indicator diagrams and types of indicators—compound engines, steam jacket—super-heatings. Mr. Westcott.

Elements of Machine Design, 10—The basis of this work is found in Klein's "Elements of Machine Design." A series of plates 26 x 40 inches are constructed covering a wide range of machine parts. There are 334 formulæ Empirical and Rational, the use of which are explained and by means of a large number of practical examples sufficient drill is obtained in using them to enable the student to make the calculations required when designing such parts of machines as screw threads, nuts and bolts, rivets and riveted joints, keys, connecting rod ends, belts, pulleys, stepped cones, shafts, end journals, neck journals, pivots, and bearings for rotating pieces. Prof. Holdsworth.

Shop Work, 10—Lathe, planer, drill, shaper or bench work. Prof. VanDervoort and Mr. Groesbeck.

JUNIOR YEAR.

AUTUMN TERM.—*Integral Calculus*, 5.—With Taylor's Elements of the Calculus as a text-book, particular attention is given to the applications of integration to arcs, areas, volumes and to some of the simpler problems of physics and mechanics. Prof. McNair.

German or French, 5.—The pronunciation, the regular forms of the language and facility in the use of the simpler and more common words, are the objects of the first term's work. Oral and written exercises are frequent. Prof. Edwards.

Chemistry, 5.—*Chemical Laboratory*, 2.—This course is general chemistry and embraces experiments performed both by the instructor and student. More time is given to the experimentation with the common metals than with the more rare elements. Prof. F. S. Kedzie.

Machine Design, 6.—Elements of Machine Design continued. Problems relating to gearing. Exact and approximate methods of laying out profiles of teeth, by circular arcs, Willis odontograph, Robinson's odontograph, tabular coördinates. Proportions of rim, arm and hub. Circular and diametrical pitch. Comparison of Cycloidal and Involute profiles. Cast and cut gears. Gear cutters. Wooden teeth or cogs. Spur, bevel and worm gearing. Proportions of worm gearing for highest efficiency. Mr. Westcott.

Rhetoricals.—One expository oration. Prof. Edwards.

Shop Work, 6.—Lathe, planer, milling machine, grinding machine, or bench work. Prof. Van Dervoort and Mr. Groesbeck.

SPRING TERM.—*Mechanics of Engineering*, 5—This term's work consists of: First, a thorough consideration of the relations of forces in problems of statics, including the subject of center of gravity; second, the dynamics of a material point; and third, the subject of moment of inertia. The text-book used is Church's Mechanics. Prof. Vedder.

French or German, 5—In this term the class is drilled in the irregular forms of the language and the fundamental ideas of syntax are inoculated. The effort is made by oral and written exercises to enlarge the pupils available vocabulary, Prof. Edwards.

Chemistry, 3. *Chemical Laboratory*, 2—The work of the previous term in Elementary Chemistry is completed. Some time is then devoted to determinations of minerals with the blow pipe. This is followed by various quantitative analysis, such as—1. Water to determine suitability for boiler purposes. 2. Boiler scale. 3. Coal for steam and metallurgical purposes. 4. Flue gasses.

Steam Boilers, 1—Particular attention is paid to materials used in construction, adaptation of different types, for different places and purposes, approved forms of setting and economical methods of management. Boiler fixtures and appliances. Mr. Westcott.

Machine Design, 6—Proportioning various parts of machines and engines, pistons, piston rods, cross heads, connecting rods, eccentrics. In this work the student is given drill in using such standard works on machine design as Unwin, Reuleaux, Marks, and Richards. Mr. Westcott.

Rhetoricals—One argumentative oration. Prof. Edwards.

Shop Work, 8—Lathe, planer, milling machine, grinding machine, or bench work. Prof. Van Dervoort and Mr. Groesbeck.

SUMMER TERM.—*Methanics of Engineering*, 5—Beginning with problems involving motion of rigid bodies, and including the subjects of work, power and friction. Prof. Vedder.

Strength of Materials, 5.—*Laboratory*, 2½—This work is partly classroom and partly laboratory work. In the testing room metals of all descriptions, wood, stone, brick, and cement are tested. An effort is made to have all tests conform to recognized standard methods and to have results worked up and handed in, on suitable blanks. Mr. Wescott.

German or French, 5—Here the reading is to review the grammar work of the two previous terms, to give same degree of sy̆ntactical knowledge, and to introduce the student to the peculiar vocabulary and word-formation of scientific treaties. Prof. Edwards.

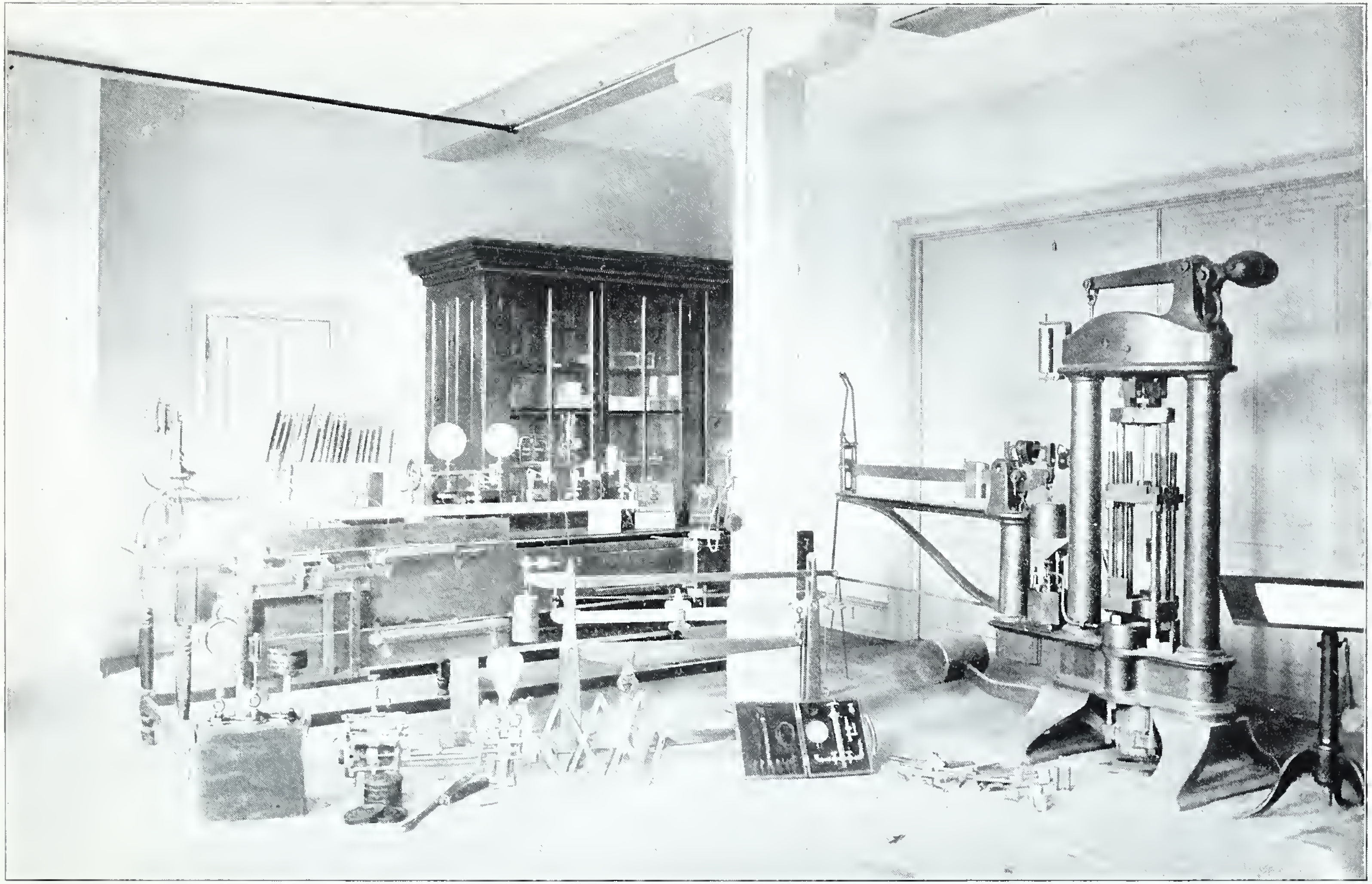
Shop Work, 10—Advanced lathe, plane milling machine, grinding machine or fitting. Prof. Van Dervoort and Mr. Groesbeck.

SENIOR YEAR.

AUTUMN TERM.—*Graphic Statics*, 3—A short course, dealing with the stresses in the simpler forms of roof-trusses and bridges, the graphic method being used. Prof. Vedder.

Valve Gears, 2—Recitations and drawing room work are required in this subject. The application of the Zeuner diagram, as an aid in the study and design of valves for engines is carefully brought out. The various kinds of valves, linkages, valve gears and cut-offs are investigated largely by reference to trade catalogs and blue prints. Prof. Breckenridge.

Thermodynamics, 5—The fundamental principles underlying the transformation of heat into work, more especially as exemplified in the steam engine, are carefully studied. Considerable attention is paid to the solution of numerous examples such as will arise in steam, air, or gas engineering as well as drill in the rapid and accurate use of standard steam tables. Prof. Breckenridge.



View in Testing Room.

Steam Engine Design, 10—Under this head the steam engine is studied very carefully. A series of plates are drawn showing for the minimum, average and maximum horse power, the pressure of steam on piston at all points of the stroke, the pressure at cross-head pin, crank pin, and crank shaft, at all angles, and taking into consideration the forces of inertia combined with the steam pressures. Proper distribution of metal in the crank disc so that the forces tending to shake the bed may be properly modified. Weight of flywheel calculated. Each part of complete engine is designed and detailed drawings are made and traced, so that blue prints are available for each member of the class. Mr. Westcott.

Rhetoricals—One oration, persuasive nature. Prof. Edwards.

Shop Work, 10—Advanced work on any of the machines in the shop, or erecting and fitting. Prof. Van Dervoort and Mr. Groesbeck.

SPRING TERM.—*Hydraulic Engineering*, 5. *Hydraulic Laboratory*, 4—This course deals principally with weir measurement, flow of water in channels and pipes, and discharge through different orifices. Prof. Vedder.

Electrical Engineering, 5. *Electrical Laboratory*, 4—A text-book study. Slingo & Brooker's Electrical Engineering is used. Lecture table apparatus is used where applicable. The laboratory work is as follows, with variations: Construction and calibration of a galvanometer adjustment of different elements and determination of electromotive series. Finding current strength by plating, by decomposition of water, by calorimeter. Determine relative values of horizontal and vertical components of earth's magnetism. Operate Wheatstone's bridge, magnetos, telephones, converters and accumulators. Determine character of a series dynamo, a shunt dynamo, and of a compound dynamo. Determine efficiency of an electric motor. Prof. Woodworth.

Kinematics, 5—A study of the nature and equivalence of mechanisms. Determination of centrodes. Graphical diagrams of the paths, speeds and acceleration of important points in familiar mechanisms. Laying out of cams. Analysis of difficult mechanisms. The work is partly class work and partly drawing. Prof. Breckenridge.

Advanced Designing, 10—The work begins with simple machines and extends to more difficult designs as the student progresses. The design of attachments to existing machines or the complete design of some machine that can be built in the shops, is often a part of this work. Such designs as hoists, pumps, drills, speed lathes, shapers, water motors, dynamos, etc., are undertaken, and the student is supplied with the same information as he would be in commercial offices for this kind of work. Prof. Breckenridge.

Steam Engineering Laboratory Work, 6—Use of the indicator and various reducing motions. Calibration of instruments such as scales gauges, indicator springs, etc. Experiments with various calorimeters. Duty trials. In addition to this, a limited amount of commercial testing is undertaken. In all this work particular attention is paid to carefully prepared reports, which are always required. Prof. Breckenridge.

SUMMER TERM.—*Civil Engineering*, 4. *Field Work*, 2—This study embraces mainly the applications of higher surveying, known as Land and City Surveying, Topographical Surveying, Railroad Surveying and Geodetic work. As might be expected, not all the refinements of the divisions enumerated are attempted in this short course. Prof. Vedder.

English Masterpieces, 5—The time will be devoted to the critical study of a half-dozen masterpieces, illustrating different periods of English literature. The object of the course is to educate the taste, cultivate a habit of thorough and critical reading, and secure an intelligent notion of the relation of literature to the social and political history of the period in which it was produced. Prof. Edwards.

Lectures on Engineering Practice, 2—The aim of these lectures is to give to the student some information and data in the many lines in which it is impossible to advance far in the regular course. Manifold copies of these lectures are furnished the student. Prof. Breckenridge.

Original Design, 6—In this work the previous training in designing is combined with the student's inventive ability, and often ingenious and valuable work is done. The work requires that machines be designed for accomplishing certain prescribed work. Often only a single piece is given the student and a machine is required to produce a given number of these pieces. A large amount of study of existing special machines is required. Prof. Breckenridge.

Oration—Subject and treatment to be suited to a supposed time and place previously selected. Prof. Edwards.

Thesis Work, 10—This work is intended to be of the nature of orignal research, and as far as possible must be without aid from instructors. A written report of all work done is required, accompanied by drawings when necessary. All these are to be handed in by the middle of July, and when accepted they are to be type written upon a uniform size of paper (8½ x 11), bound, and left at the College with the department for future reference. Prof. Breckenridge.

INSTRUCTION IN THE SHOPS.

In the shops the students are advanced in the work as fast as their ability will permit. The work, as far as possible, is applied toward the construction of some useful article or machine which is turned into the shop equipment. Although the shops are operated on a practical basis they are in no way interested in commercial work. The student receives no pay for his work. The policy of the department is to give the student every possible advantage and to teach him to produce accurate work in the shortest possible time.

Beginning with the care and use of the tools with which he is to work, the student is carried through the various operations of machine shop practice. The students have already built four engine lathes, four iron bed wood lathes, one pattern maker's lathe, one twenty-five horse-power engine, one fifty incandescent light dynamo, one twelve-inch iron shaper, one twist drill grinder, one improved center grinder, one steam pump, one wood-boring machine, one air compressor, one pair planer centers, one buzz planer, and one combination buzz saw, besides various small articles. Since the addition of the universal grinding machine to the shop equipment, the students have done a large variety of work on hardened steel, as plain and angle milling cutters; rose, shell and taper reamers; hardened steel mandrels; standard plugs, rings, etc. There are at present under construction in the shops one fifty-horse-power high speed tandem compound engine which, when completed, will be used to drive the shops; two iron-bed wood lathes, one boring and facing attachment, and various small tools. In the forge shop the students are taught the methods of forging and welding iron and steel, special attention being given to the forging and tempering of lathe and planer tools.

Accurate record is kept of the progress of each student, and at the end of his course, if desired, papers will be furnished giving record of skill.

Besides the required work, which is usually ten hours per week, students are encouraged to attain additional skill by having allowed to them, on Saturday forenoon, when circumstances will permit, the privileges of the shop for any work which they may undertake for themselves.

Several students have built vertical engines of from one to six horse-power, and several small dynamos.

The iron shop is provided with a separate tool room, and is conducted the same as a manufacturing establishment.

The machine and wood shops are each fifty by sixty feet, two stories. Connected with the machine shop is the forge shop, thirty feet square. It is expected that a foundry, sixty feet by thirty feet, with modern cupola and equipment, will be ready for the students by the last part of the fall term, 1893. The equipment of the shops is as follows:

Machine Shop:

1 twenty-five horse-power engine, driving 195 feet of line shaft.
1 twenty-four inch Putnam lathe, twelve foot bed with compound rest.
1 eighteen inch Reed lathe, eight foot bed.
1 sixteen inch Pratt and Whitney lathe, seven foot bed with Slate's taper attachment.
2 ten inch Reed lathes, five foot bed, screw cutting.
2 fourteen inch lathes, five foot bed, made in shops.
2 ten inch lathes, seven foot bed, made in shops.
1 fourteen inch Turret lathe, five foot bed, made in shops.
1 ten inch Warner & Swasey speed lathe.
1 twenty-four inch by twenty-four inch by eight foot bed, Gray planer.
1 twelve inch shaper, made in shops.
1 six inch Boynton shaper.
1 Reed power drill-press.
1 Slate's sensitive drill-press, with centering attachment.
1 Slate's Universal tool grinder.
1 No. 1 Brown & Sharpe Universal Milling Machine, with attachments.
1 No. 2 Improved Brown & Sharpe Universal Grinding Machine, with attachments.
1 four foot Betts Universal Radial Drill, with attachments.
1 complete set of machinist taps to 1⅛ inches, with friction sockets, for use in drill press. (Presented by Beaman & Smith, of Providence, R. I.)
1 twist drill grinding machine.
1 center grinding machine.
1 Stover Power Hack Saw.
1 Gisholt Universal tool grinding machine.
Also a complete assortment of small tools and gauges.

Wood Shop:

4 ten inch iron bed wood lathes.
2 ten inch wood bed wood lathes.
1 pattern maker's lathe.
1 Clement's band saw.
1 Clement's two spindled shaping machine.
1 sixteen inch, Frank & Co., double surfacing planer.
1 combination buzz saw.
1 Fox trimmer.
1 iron frame miter saw.
40 cases of tools and a good assortment of miscellaneous small tools.
1 buzz planer.
1 boring machine.
The shop is equipped with thirty patent iron vises.

Forge Shop:

11 improved forges, receiving a pressure-blast from a Sturtevant blower.
2 vises and a good assortment of forge shop tools.
1 brass furnace and one tempering furnace.